STOWATERFL VERSION 1.2 USER'S GUIDE

Program Documentation

STOWATERFL is a program that routs drainage water and runoff from multiple sub-basins given a DRAINMOD daily output file for each sub-basin area to a storage reservoir, then routs water to multiple irrigation areas given a DRAINMOD output file of each of the irrigated fields. The program records a daily water balance based upon evaporation data from an evaporation file created by STOEVAP.EXE. The output from the STOWATERFL program consists of values for rain, evaporation, drainage, irrigation, sub-basin flooding, reservoir storage, reservoir overflow, dry days, and irrigation deficit on a daily, monthly, and/or yearly basis.

Installing the Program

This program can be obtained from the State Conservation Engineer. Once obtained, the program should be run to install the program. The program will create a directory C:\ProgramFiles\usda\STOWATER\

Running STOWATERFL

The following gives some basic information in running the program. From Windows Explorer, change to the directory where the program file, STOWAT.exe, is located and click on the file to start the program. CCE machines should also be able to start the program by going to the start menu, then to Programs, then to Engineering Applications, and then to STOWATER and clicking on the icon.

Alternatively, from a DOS prompt change the directory to C:\ProgramFiles\USDA\STOWATER\ and type STOWAT at the DOS prompt and follow the instructions. The program has a help menu and is easy to follow. It is recommended that the example file be examined and run before using this model.

Program Procedures

Files Needed

Five different types of data files are needed for this program. They are as follows:

1. Evaporation file from STOEVAP.EXE. This file is created by running STOEVAP.EXE for a DRAINMOD file which has been run with no water restrictions and PET values set for a free water surface for the area under consideration. This is typically done by using the sub-surface irrigation option in DRAINMOD with the irrigation level set at a height which will allow the crop to have maximum evaporation all the time. The subirrigation weir height should be set at a level that is higher than the root depth. PET values should be set at 0.7 - 0.8 or values for short pasture grass.

2. One file, xxxx.sub, containing the path and filenames of the daily output from DRAINMOD for the drainage sub-basins and their areas in acres. See the example file, DRAIN.SUB in Exhibit A, for proper format. This file is easily created by using a text editor and edit the sample file, DRAIN.SUB.

3. One file, xxxx.sub, containing the path and filenames of the daily output from DRAINMOD for the irrigation areas, the irrigation system type, irrigation depth, and irrigation efficiency for each of the irrigated areas. See the example file, IRR.SUB in Exhibit B, for the proper

format. Irrigation type should be "sub" for subirrigation and "surf" for surface irrigation. The next column, "Irrg", is the surface irrigation depth in inches. It must be entered for surface irrigation files, but is not used for subirrigation files. Irrigation efficiency, the sixth column, should be included for all irrigated areas and is described in greater detail later. This file is easily created by using a text editor to edit the sample file, IRR.SUB.

4. Up to seven drainage sub-basin DRAINMOD daily output files, xxxx.day

5. Up to seven DRAINMOD daily output files for the irrigated areas, xxxx.day

Input Needed

Input data for STOWATERFL is as follows:

A. Name of the system.
B. Inflow from external sources (i.e. washwater) to the reservoir in gallons per day.
C. Drainage rate from the drainage areas (i.e. pumping rate) in gallons per minute.
D. Surface area of the reservoir in acres.
E. Overflow depth in the reservoir in feet.
F. Name of the PET file with correct pathname.
G. Name of the drainage sub-basin file with correct pathname.
H. Name of the irrigated sub-basin file with correct pathname.
I. Year, month, and day of the beginning and ending dates to run the STOWATER model. Note these dates must be within the dates as run for all of the DRAINMOD output files.
J. Enter a "y" for daily output or a "n" for no daily output. Yearly and monthly summaries will be printed for both options.

Output Definitions

The program creates three output files (daily.out, monthly.out, and yearly.out) and will create an input data file which can be used to run the program again later. This filename is user defined. The variables within the three output files are as follows:

YEAR - year table values pertain to.
RAIN - sum of rain for year.
MAX-FLOOD- maximum depth the drainage areas flood (limited by pumping rate).
DRAINAGE - sum of drainage depth for the drainage areas.
RES-INF - reservoir inflow for the year in inches.
RES-EVP - reservoir evaporation for the year in inches.
IRRG- sum of irrigated depth for year over total irrigated area.
MAX-STOR - maximum storage in the reservoir during the year.
OVERFLOW - overflow from the reservoir in inches/area of the reservoir.
DRY DAYS - number of days that the reservoir is empty when irrigation is needed.
IRR-DEF - sum of the irrigation deficit for the year.
AVG - average of the simulated values.

Daily and monthly output files are similar with values pertaining to day and month respectively instead of year.

Program Notes

Irrigation Calculation

Rain values are calculated from the PET file rain values. Irrigation is calculated by comparing each days rain value from each irrigated area daily file with the actual rain value for the reservoir (i.e. rain in the PET file). DRAINMOD adds irrigated depth to the rain value, therefore an irrigation event has occurred if the two rain values are different; if the two values are different, STOWATERFL calculates the irrigation volume based upon the irrigation depth, "Irrg", in the irrigation sub-basin file. It is therefore important that the irrigated depth listed with each irrigation sub-basin file be the same as the depth used in the DRAINMOD file used to create it.

NOTE: It is very important that the rainfall data files used to develop each of the DRAINMOD irrigated area daily output files be the same as the data file used to develop the PET daily output file. Otherwise the irrigated volume will be severely over estimated. This same problem will occur if the DRAINMOD file used to create the PET daily output is surface irrigated. DRAINMOD would add the surface irrigated volume to the rain values in the PET file and thus STOWATERFL would not use the true rain values for its calculations.

STOWATERFL checks the reservoir to see if enough water has been stored to irrigate. If there is not enough water, STOWATERFL calculates the irrigation deficit and adds to the number of dry days. Note that there is no interaction between STOWATERFL and DRAINMOD; therefore, DRAINMOD output may reflect an irrigation event when none has actually occurred.

Irrigation efficiency is used in the calculation to account for water which is withdrawn from the reservoir but is lost from the irrigation system and not available to the plants.

Reservoir Calculation

Each day STOWATERFL computes a water balance for the reservoir. Reservoir storage = External inflow + drainage sub-basin inflow (runoff and drainage) + rain on the reservoir - evaporation - irrigation outflow - any overflow. Overflow occurs when the daily inflow minus the daily outflow adds enough water to the reservoir to make the reservoir depth greater than the maximum allowable. The volume above the overflow depth is overflow and removed from the system. The reservoir volume is calculated by reservoir surface area times the height. If the reservoir is non-uniform, calculate the reservoir volume at overflow and divide by the area to calculate an adjusted height for the purpose of use in STOWATERFL. The reservoir area should not be altered since this area is used in several key calculations (i.e. reservoir evaporation outflow and rain inflow).

Drainage Sub-basins

Drainage sub-basins are usually the major source of inflow to the reservoir. The sub-basin area should represent the area which contributes runoff to the reservoir both by surface runoff and subsurface drainage. Channels which route flow around the boundary of a sub-basin may actually draw water from outside the basin if the water table is above the bottom of the channel. Channel drawdown of a high watertable could have a significant affect under certain conditions.

Example

An example input set and DRAINMOD data files are included. To run the example, type EXAMPLE.DAT at the first prompt in the program.

SAMPLE INPUT FILES

EXHIBIT A - DRAINAGE FILE for EXAMPLE.DAT

Drainage Sub-Basins

DRAIN.SUB	
DRAINMOD daily output filenames used in simulations	Drainage Area (Acres)
C:\STOWAT\LAMBDRN.DAY	10.0
C:\STOWAT\IMM.DAY	25.0
C:\STOWAT\LAMT.DAY	15.0

EXHIBIT B - IRRIGATION FILE for EXAMPLE.DAT

Irrigation Sub-Basins

IRR. SUB				
DRAINMOD Daily Output Filenames use in Simulation	Irr. Area Acres	Irrg. Type sub or surf	Irrg (in)	Irr Eff%
C:\STOWAT\LAMBIRR.DAY	25.0	Surf	0.5	85
C:\STOWAT\IMMIRR.DAY	10.0	Surf	1.5	85
C:\STOWAT\LAMSUB.DAY	45.0	Sub		95

EXHIBIT C - SAMPLE OUTPUT from EXAMPLE.DAT

STOWATER 1.2 YEARLY SUMMARY

Yearly summary for LAM 03-24-92

Inflow from external sources, gal/day-----: 20000
Drainage rate from drainage areas, gpm ---: 1000
Surface area of reservoir, acres ---------: 70
Overflow depth in reservoir, feet --------: 4
Name reservoir PET file ----------:c:\stowat\LAMEVP.SW
Name of drainage sub-basin file----------:c:\stowat\drain.sub
Name of irrigation sub-basin file --------:c:\stowat\irr.sub

Drainage Sub-Basins

EXHIBIT C - (Continued)

DRAINMOD daily output filenames used in simulations	Drainage Area (Acres)
C:\STOWAT\LAMBDRN.DAY	10.0
C:\STOWAT\IMM.DAY	25.0
C:\STOWAT\LAMT.DAY	15.0

Irrigation Sub-Basins

IRR. SUB				
DRAINMOD Daily Output Filenames use in Simulation	Irr. Area Acres	Irrg. Type sub or surf	Irrg (in)	Irr Eff%
C:\STOWAT\LAMBIRR.DAY	25.0	Surf	0.5	85
C:\STOWAT\IMMIRR.DAY	10.0	Surf	1.5	85
C:\STOWAT\LAMSUB.DAY	45.0	Sub		95

YEAR	RAIN	MAX-FLOOD	DRAINAGE	RES-INF	RES-EVP	IRRIG	MAX-STOR	OVERFLOW	DRY	IRR-DF
	(in)	(in)	(in)	(in)	(in)	(in)	(ac-in)	(in)	DAYS	(in)
1962	55.7	0.0	24.1	76.7	48.2	21.2	1462.1	0.0	85	15.2
1963	37.3	0.0	5.4	45.0	35.1	17.5	935.8	0.0	124	17.0
1964	41.7	0.0	.7	51.1	41.9	16.1	592.8	0.0	100	13.4
1965	46.4	0.0	11.6	58.5	43.4	16.4	576.3	0.0	116	11.6
1966	55.0	0.0	23.6	75.7	45.8	22.9	1499.5	0.0	16	2.1
1967	51.0	0.0	19.3	68.6	38.0	19.8	1617.1	0.0	57	8.4
1968	57.6	0.0	26.1	80.1	41.5	24.5	2342.9	0.0	4	0.3
1969	65.5	0.3	32.5	92.6	46.2	22.5	3181.0	0.0	0	0.0
1970	50.1	0.3	21.0	69.0	42.5	30.3	3360.0	13.7	0	0.0
1971	57.3	0.3	22.5	77.2	44.0	26.7	2645.9	0.0	0	0.0
1972	43.2	0.0	9.3	53.8	40.5	31.3	1770.8	0.0	0	0.0
1973	49.6	0.0	14.7	64.0	48.0	19.9	824.2	0.0	57	6.1
1974	54.3	0.0	19.3	72.0	43.5	18.0	1757.7	0.0	90	10.9
1975	35.7	0.0	4.9	43.0	36.4	18.5	756.1	0.0	98	11.5
1976	43.4	0.0	14.8	57.9	36.1	17.0	929.4	0.0	81	6.9
1977	36.9	0.0	6.5	45.4	34.0	12.2	506.4	0.0	125	17.5
1978	47.3	0.0	15.4	62.1	46.9	20.9	779.4	0.0	49	5.1
1979	61.5	0.7	30.8	87.4	46.3	25.1	2004.2	0.0	11	1.3
1980	39.3	0.0	7.9	48.8	37.3	24.3	1220.5	0.0	52	6.1
1981	37.1	0.0	5.9	45.1	37.8	12.0	608.5	0.0	165	17.1
1982	63.4	0.3	26.5	86.1	47.5	23.1	1510.1	0.0	37	2.8
1983	60.2	0.0	30.9	86.1	39.4	20.4	2614.8	0.0	0	0.0
AVG	**49.5**	**0.1**	**17.3**	**65.7**	**41.8**	**20.9**	**1522.5**	**0.6**	**58**	**7.0**